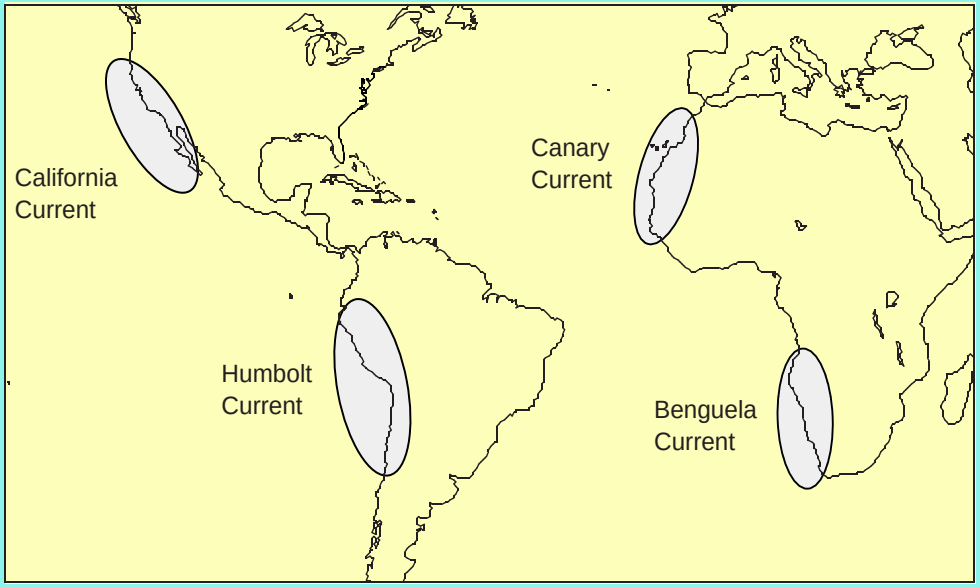
THE “CEOS” PROGRAM

Climate and **E**astern **O**cean **S**ystems

The dynamics of marine resources and their exploitation in face of variability and changing climatic regimes

NOAA

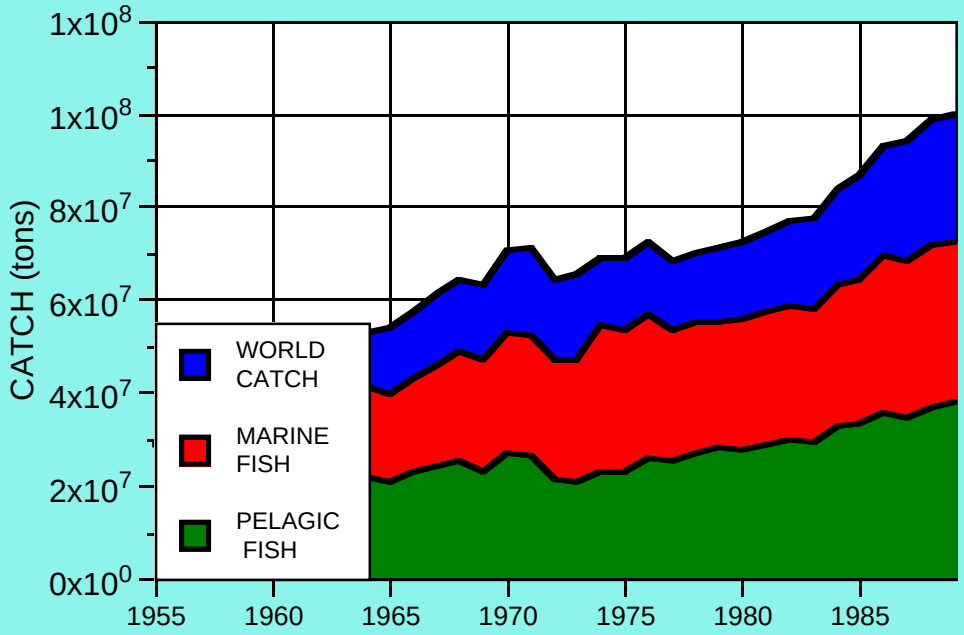


ORSTOM

ICLARM

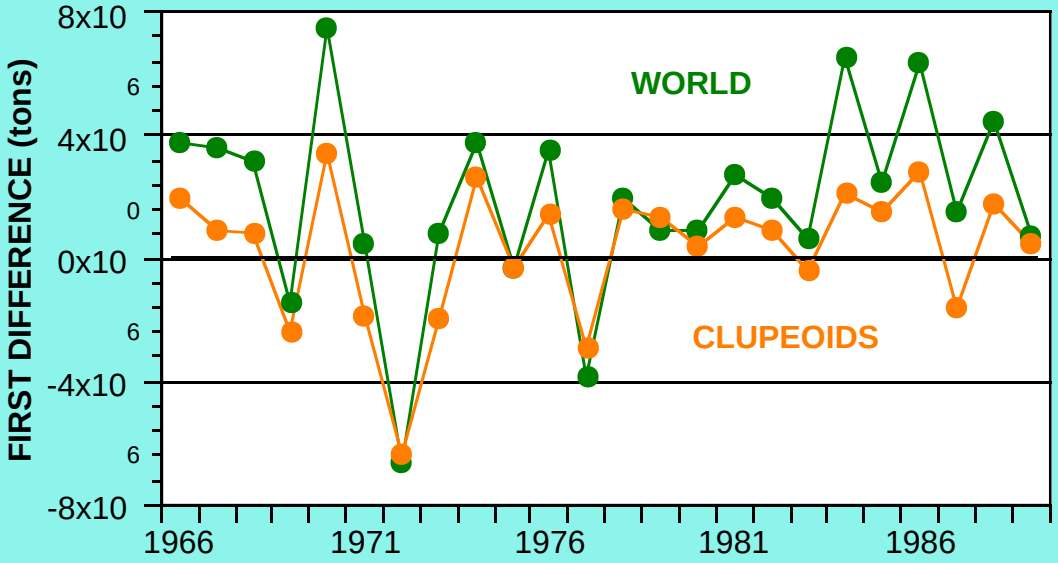
MARINE RESOURCES AND UPWELLING REGIONS

Almost 50% of the world's catch of fish are from upwelling regions.

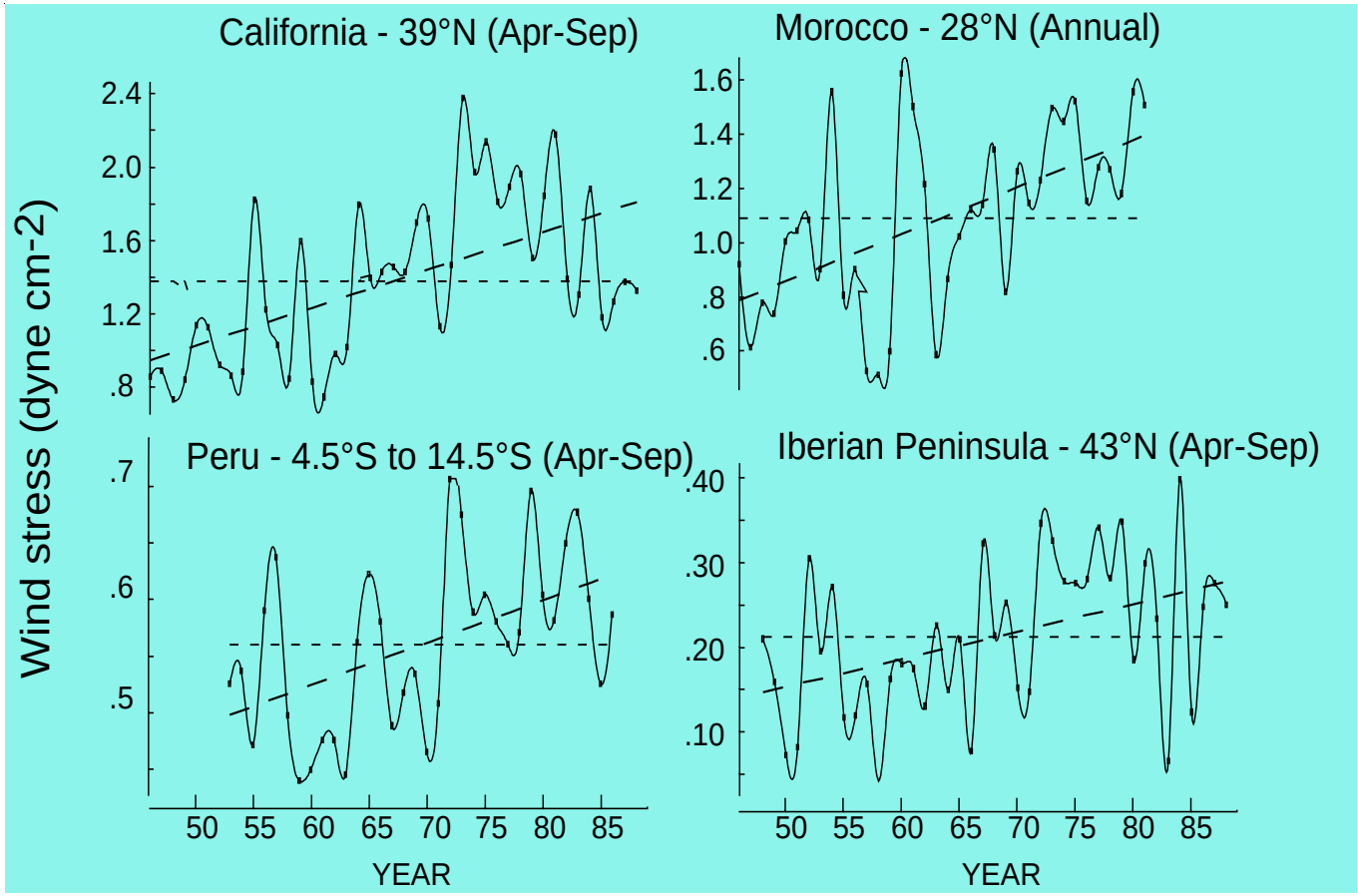


VARIABILITY OF MARINE RESOURCES IN UPWELLING REGIONS

The essential variability in the world fish catch is due to variability in coastal pelagic fish catches



ENVIRONMENTAL VARIABILITY IN COASTAL UPWELLING REGIONS



METHODOLOGICAL APPROACH

We can't perform experiments at the ecosystem level;

Comparison and observation are as valid scientific research methods as experimentation;

Recognize the importance of the past history in ecosystem evolution.

- **COMPARATIVE APPROACH**
  - **Identify the emergent and contingent properties of ecosystems, as defined from "systems studies";**
- **HISTORICAL APPROACH**
  - **Study the past in order to identify possible system responses due to variability and change;**

THE CEOS PROGRAM

- **A THEME**
  - **Variability and change;**
- **THE DOMAIN OF APPLICATION**
  - **Coastal upwelling systems;**
- **RESEARCH ACTIONS**
  - **Global climate change and the dynamics of coastal upwelling;**
  - **Resource dynamics and environmental variability;**
  - **Resource exploitation and use in the face of uncertainty.**

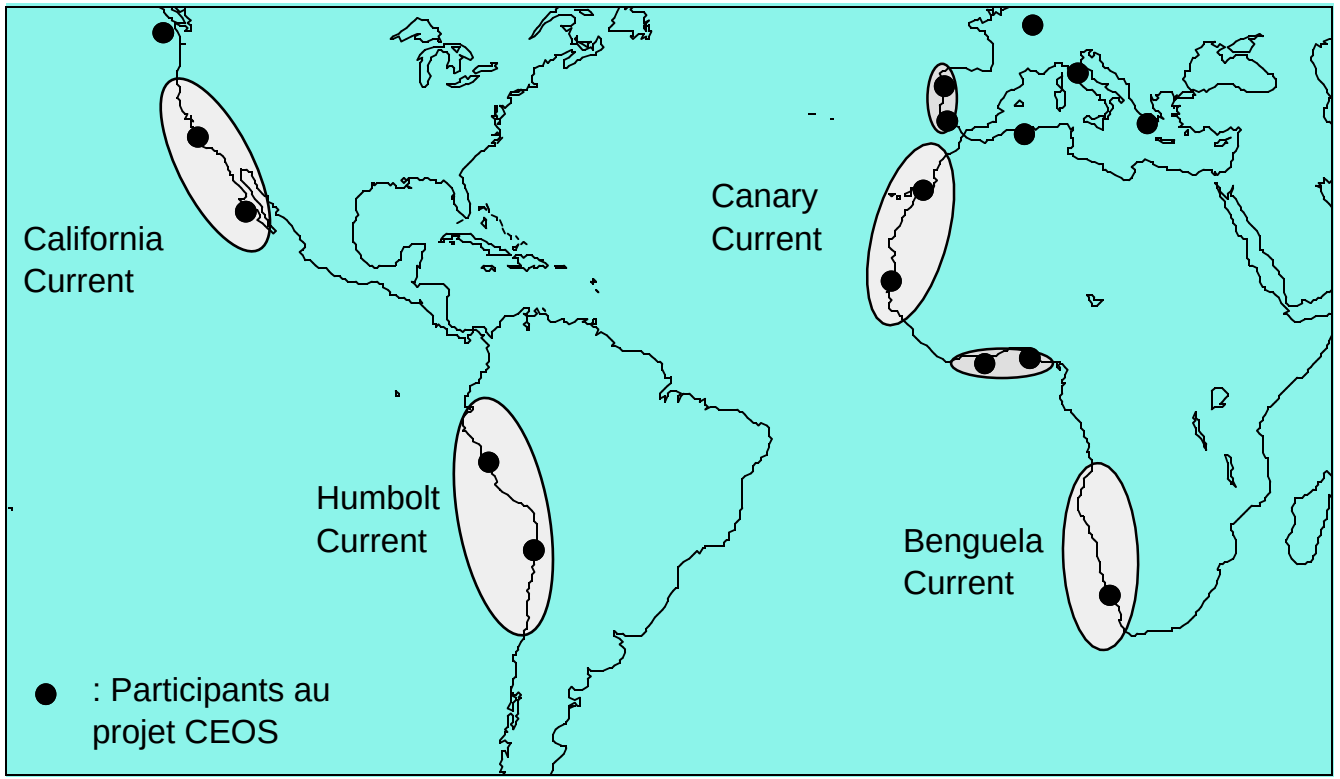
THE OBJECTIVES

- Assemble the historical datasets from the principal upwelling regions;
- Characterize the environmental and the resources fluctuations in the principal upwelling zones at different time and space scales;
- Identify the environmental processes that are likely to affect the dynamics of pelagic resources;
- Explore the relationships between global climatic fluctuations and local dynamics;
- Analyze the social and economic responses to resource variability;
- Construct exploratory scenarios of possible ecosystem responses in the face of climate change;
- Establish a network of researchers around the scientific themes of the CEOS Program.

Some results of CEOS

- Dynamics of the world market for fish meal (ORSTOM-FEO);
- Time series and climate change : reality and artifacts (ORSTOM-PFEG);
- “ECOPATH” models of the major upwelling regions (ICLARM);
- Spatial dynamics of the Moroccan pelagic fishery (ISPM-ORSTOM);
- Major ecological changes in the Eastern Pacific (CHILE-ORSTOM-PFEG);
- The importance of individuals to the population dynamics (ORSTOM);
- Databases (PFEG-ORSTOM + CEOS participants);
- An operational network of 40 scientists.

THE CEOS NETWORK



Over forty participants from more than 15 countries.

ACTIVITIES OF THE CEOS NETWORK

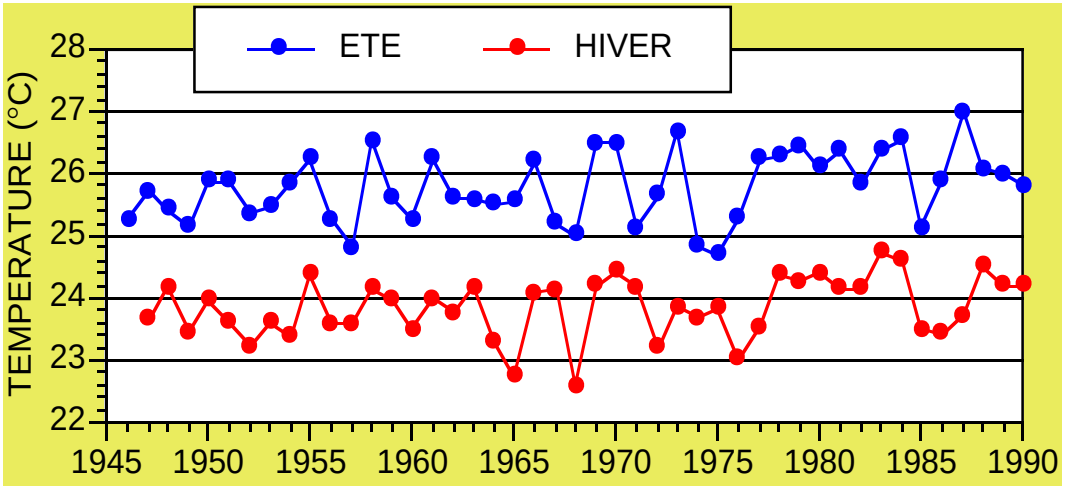
- **Develop comparative studies between the different upwelling regions;**
- **Promote scientific exchanges (databases, methodologies, knowledge...);**
- **Coordinate and encourage research on the theme of global versus local changes in upwelling systems (meetings, working groups...);**
- **Develop new research themes: spatial approaches (teleconnections, ...), renewable resources and biodiversity, long-term changes and resource exploitation.**

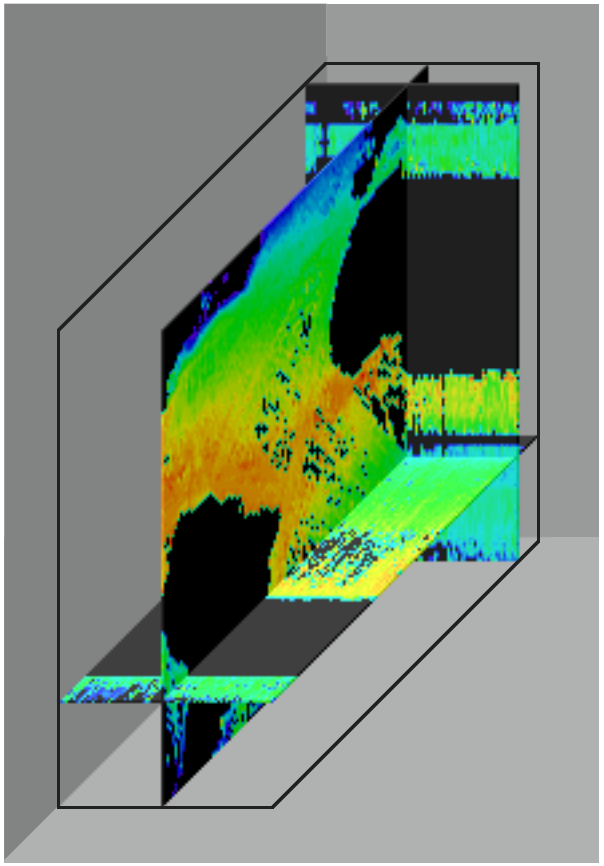
The CEOS Databases

- **Fishery and biology : FAO catch data, national catch and ecological data, oceanographic cruises, ...**
- **Economic: international markets, national statistics;**
- **Environmental : COADS data, meteorological stations, oceanographic data.**

The COADS data on a micro-computer : a product of the CEOS Project.

- Transferred the COADS data onto a microcomputer with the collaboration of NCAR;
- Standardize the database structure.
- Developed a program to access and summarize the data.
- Distribution of the database and the access program (Macintosh, DOS, WINDOWS) on CD-ROM's.

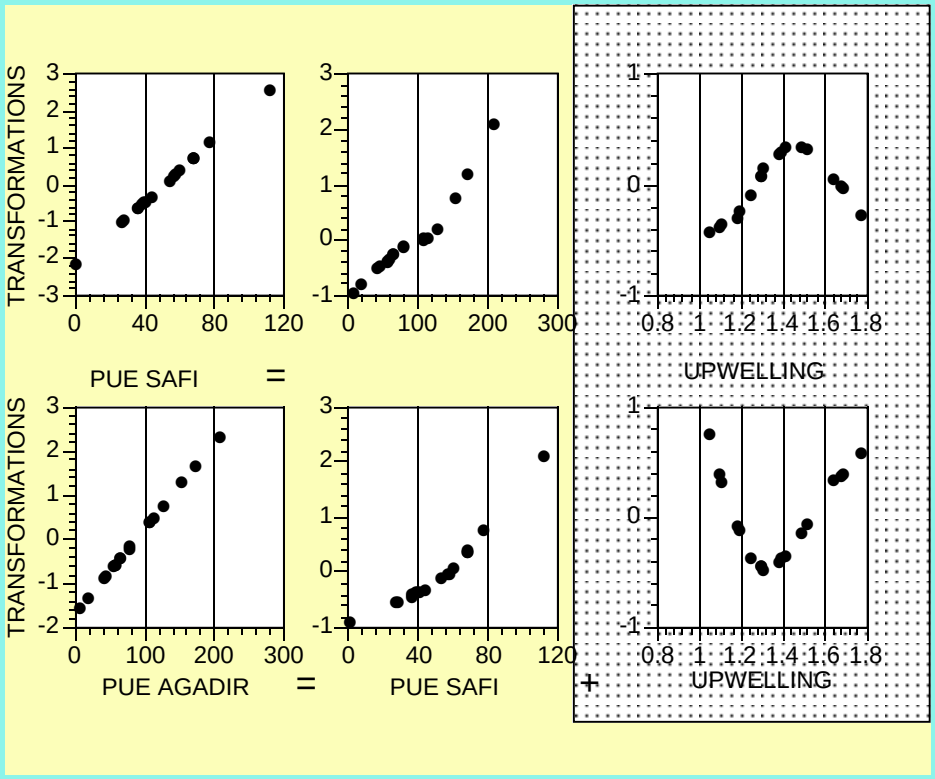


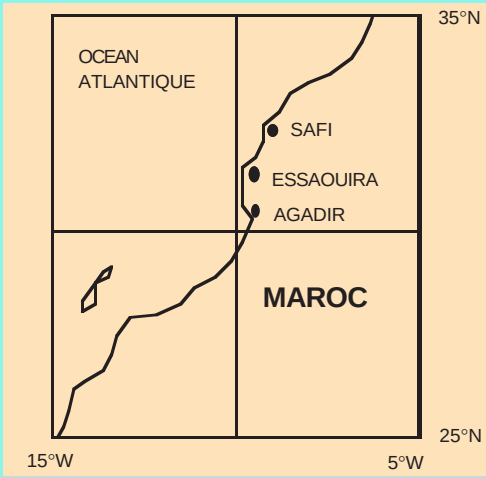


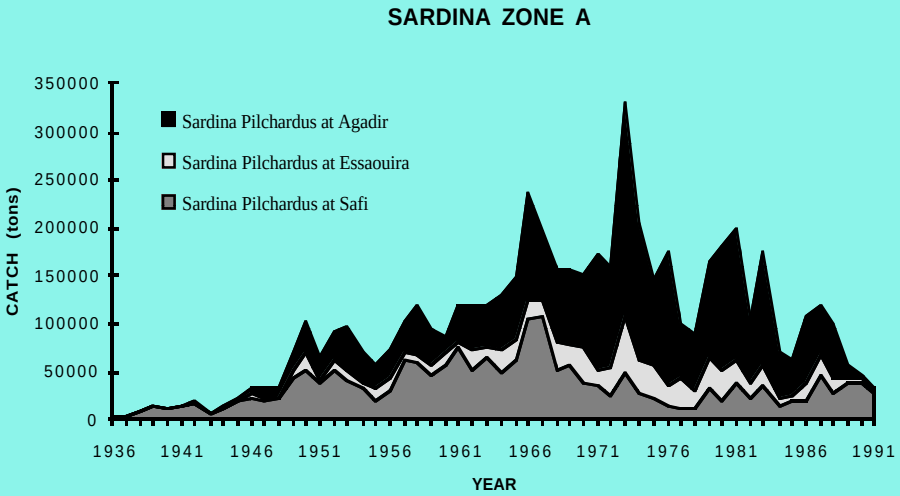
STATISTICAL CHARACTERIZATION OF CHANGE

- **TRENDS**
  - **global and/or local variability;**
  - **a long-term trend or change in the seasonal component;**
  - **Time and frequency domains are both to be considered.**
- **NON-STATIONARY SPECTRA**
  - **Changes in the variance structure through time**
- **REGIME SHIFTS**
  - **Possibility of testing for regime shifts**
- **LONG-TERM MEMORY**
  - **Persistence of events through time**

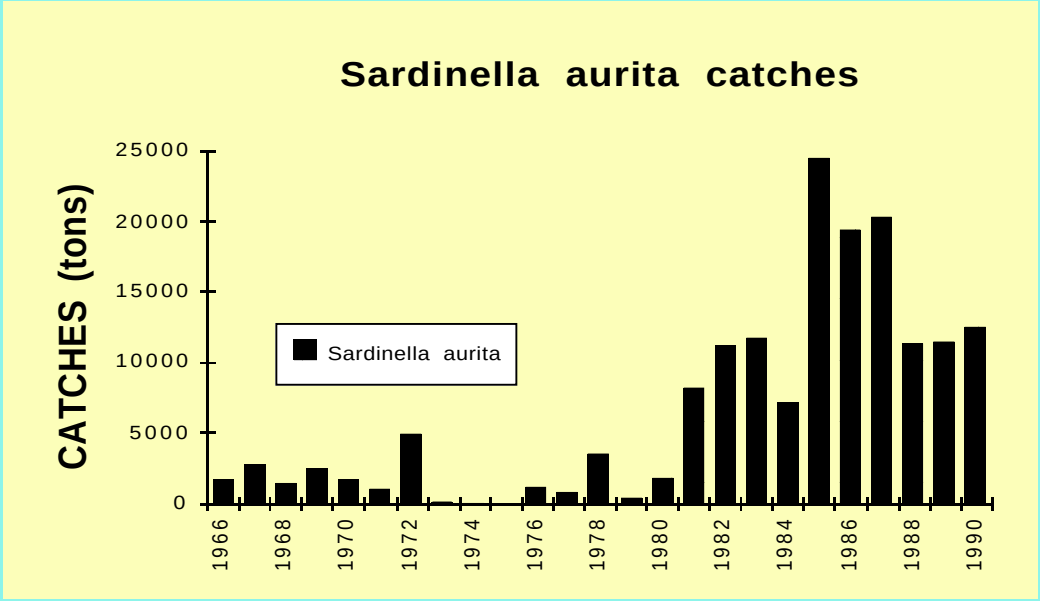
SPATIAL DYNAMICS OF THE MOROCCAN SARDINE

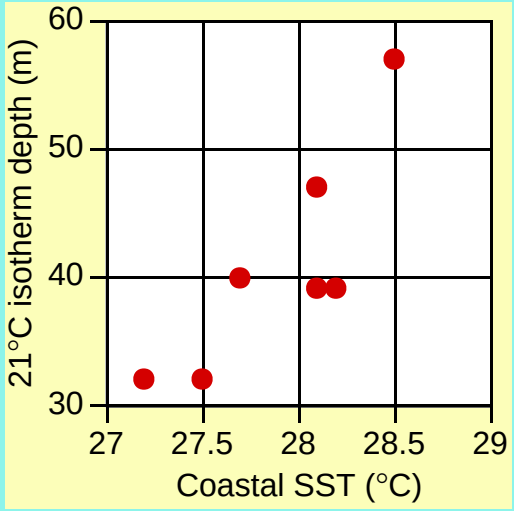


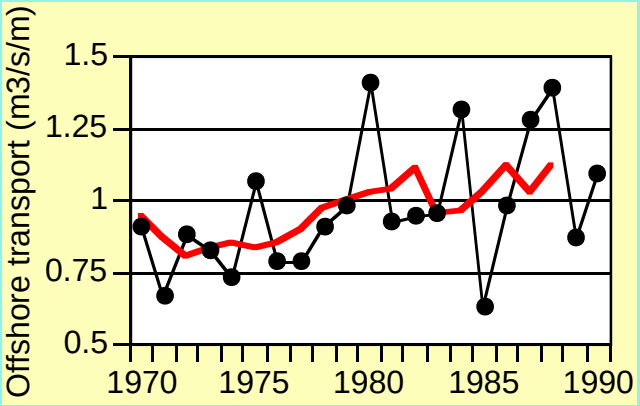


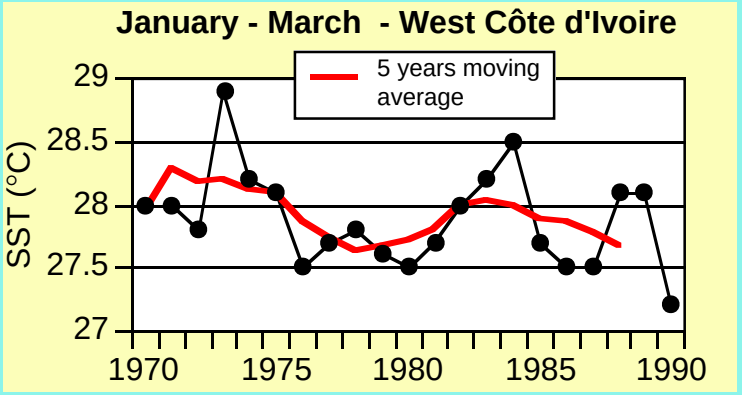


THE RECENT OUTBURST OF THE IVOIRIAN SARDINELLA



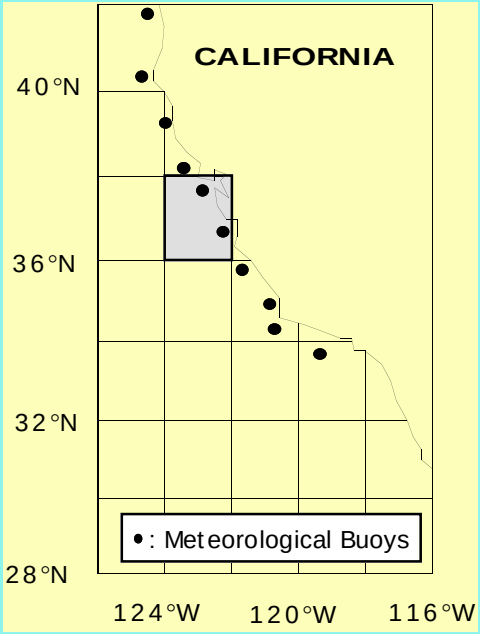


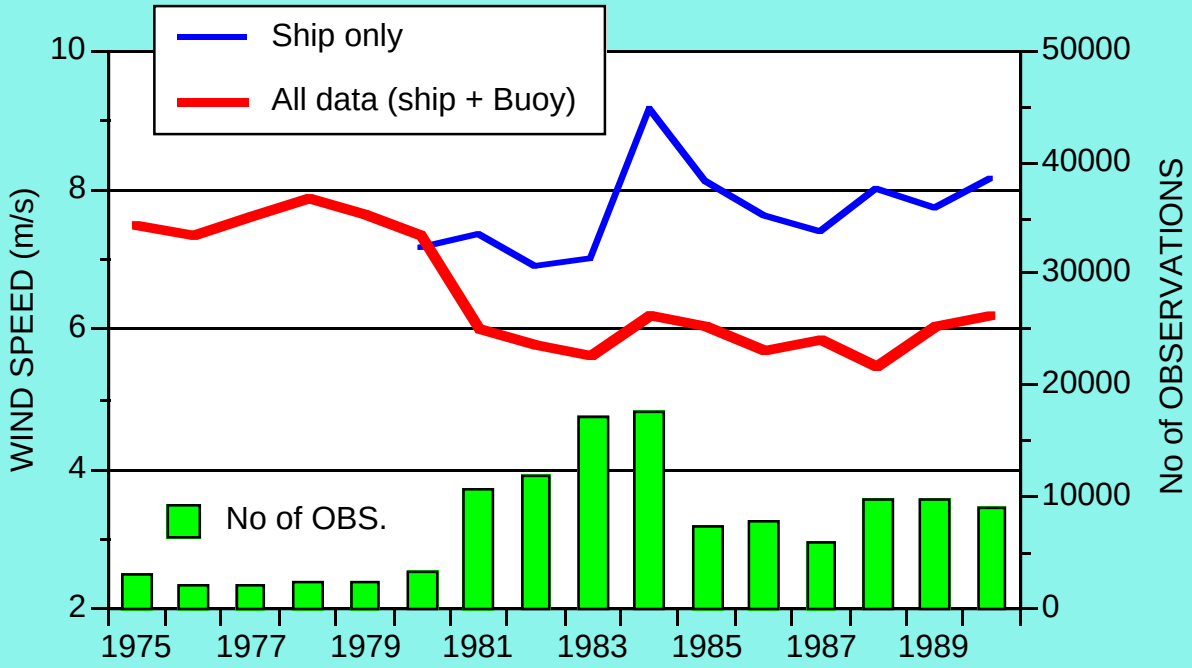




BIASES IN LONG-TERM ENVIRONMENTAL DATA SERIES (1)

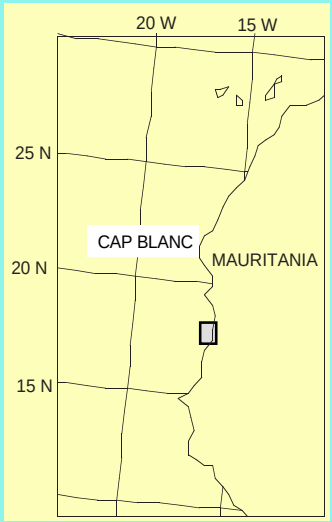
MERGING DATA FROM DIFFERENT ORIGINS

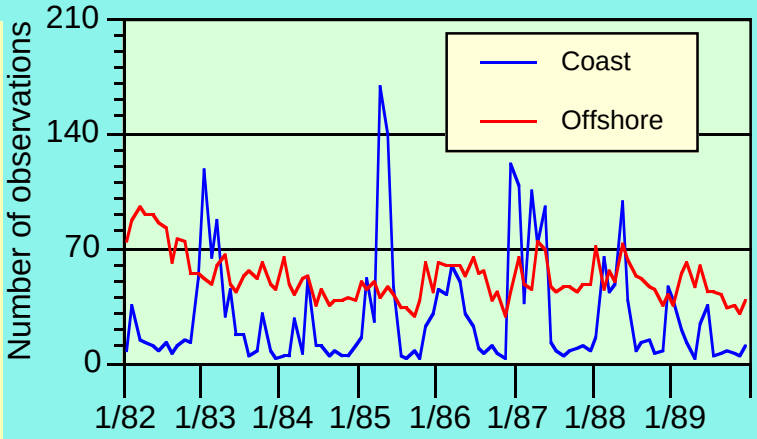




BIASES IN LONG-TERM ENVIRONMENTAL DATA SERIES (2)

Changes in the density of the data

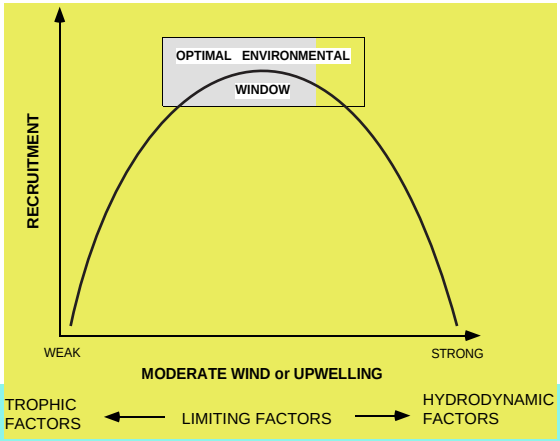


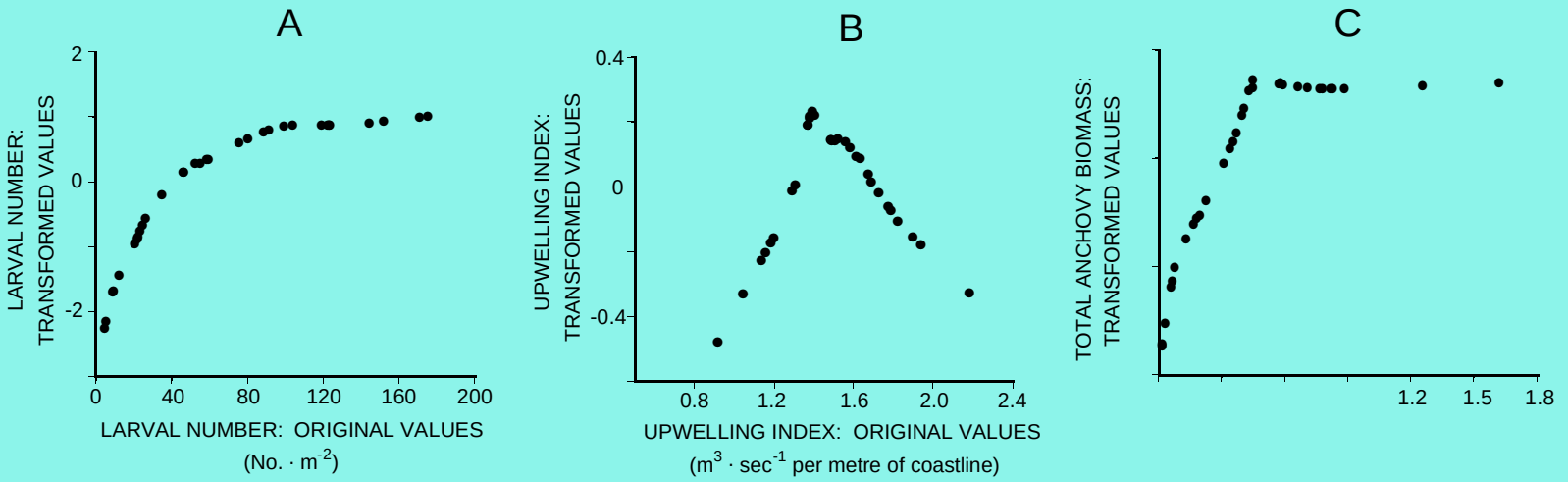


Monthly number of surface meteorological observations in the COADS data set in an area located off The coast of Mauritania.

Off the coast of Mauritania the seasonal activity of the fishing fleet follows the seasonal extension of the upwelling. The number of meteorological observations collected along the coast shows a pronounced seasonal cycle. Further offshore, along the commercial ship route, the number of observations remains steady.

THE LARVAL ANCHOVY OFF CALIFORNIA AND THE OPTIMAL ENVIRONMENTAL WINDOW





Optimal empirical transformations from the ACE algorithm using larval number as the dependent variable and upwelling index and total anchovy biomass as the predictor variables. The shapes of the transformations are found by plotting the empirically transformed values of a variable versus their original values. The plots are for the years 1951 to 1990 for: (A) mean annual anchovy larval number (this variable is standardized in the ACE algorithm); (B) mean annual upwelling index; (C) total anchovy biomass.

CEOS BUDGET

- **FUNDING FROM NOAA (NON-NMFS)**
  - **Initial Funding - $141.8K**
  - **Enhancement - $ 43.2K**
- **FRENCH GOVERNMENT**
  - **ORSTOM $160K per year**

ORSTOM RESEARCH IN WEST AFRICA

ORSTOM Facilities

1 ORSTOM research vessel
1 remote sensing station (UTIS) in Senegal
1 laboratory (fully equiped for chemical analysis) in Senegal

Joint research projects between ORSTOM and national centers

Senegal and Côte d'Ivoire (20 ORSTOM scientists and technicians)

Large pelagics (stock assesment, biology, migration, ...)
Small scale fisheries (modeling fishing strategies, ...)
Small pelagics (acoustic survey, relation with the environment , ...)
Demersal fisheries (stock assessment, ...)
UTIS : remote sensing station (SST, vegetation index, ...)
environment (coastal stations, cruises, ...)
acoustic survey (stock assessment, schools dynamics, ...)
CEOS participants

Mauritania (2)

Octopus (population dynamics, ...
stock assesment
acoustic survey

Guinea (5)

Stock assessment, trawling survey

Morocco and Ghana

CEOS project (economy, biology and environment)